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### At Cermak

#### Citation for published version:

MacKenzie, D 2014, 'At Cermak' London Review of Books, vol. 36, pp. 25.

#### Link:

[Link to publication record in Edinburgh Research Explorer](#)

#### Document Version:

Peer reviewed version

#### Published In:

London Review of Books

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If you want to see the heart of the interconnected digital world, you have to visit a data centre. It's a room or an entire building housing computers, network connection equipment and telecommunications links. Many data centres are built for the exclusive use of just one company, such as Google, but others host – and interconnect – systems belonging to many different users.

One of the world's largest multi-user data centres was once a high-volume printworks. R.R. Donnelley & Sons' Calumet Plant, on East Cermak Road on the southern edge of the Chicago Loop, printed *Time*, *Life*, the Sears Roebuck catalogue, telephone directories. The building is now a data centre used by – amongst others – telecommunications companies, financial exchanges and automated trading firms.

A data centre is no more detached from the brute physical world than a printworks was. Cermak (as the data centre is universally known in the business) is full of *stuff*. No individual computer server is particularly heavy, but there are tens of thousands of them, along with hundreds of miles of cabling, giant generators and transformers, 30,000-gallon tanks of diesel and big power distribution units. So it's just as well that Cermak's floors had been reinforced to carry heavy printing presses. Cermak's rooms are also no less noisy than they would have been in its time as a printworks, although the clanking of machines has been replaced by the steady roar of multitudes of fans and hard discs.

Three physical phenomena shape a data centre: signals, electricity and heat. The signals that encode digital information are, ultimately, electromagnetic impulses. The man who showed me around Cermak works for a firm called Steadfast, which rents out space there. He pointed to a cable no thicker than a kettle flex, and told

me it was a ten-gigabit fibre-optic connection: it could carry ten billion binary digits every second.

Those cables have to meet, for example in order for the separate, private networks owned by carriers such as Comcast, Verizon and BT to fuse to form the seemingly unitary, public Internet. As we walked Cermak's endless, windowless corridors, with their white walls and anonymous blue doors, we paused (not for too long, because Cermak is under continuous video surveillance, and we didn't want to create suspicion) outside Cermak's 'Meet-Me Room'. That's where the crucial cables connect and the fusion takes place. 'The backbone of the Internet' goes through Cermak, my host told me. The building's original design helps it to be an efficient meeting point. The Calumet Plant had 21 big vertical shafts, through which giant rolls of paper were raised and lowered. Cables that connect up its eight floors now run through those shafts, shortening the paths through the building that signals have to follow.

Everything that goes on in Cermak requires electrical power. Reflecting on what it was he did, my host told me what he thought of as its core: 'I sell electricity.' Cermak is the second biggest electricity consumer in Illinois, after Chicago's O'Hare Airport. Its supply must never fail. Cermak is connected to three different electrical grids, and the tanks of diesel are there to fuel the big generators – of the type, my host told me, that power cruise liners – that would kick in if all three grids went down.

Nearly all the electricity that flows into Cermak is transformed eventually into heat. Because of the resultant need for fierce air conditioning, data centres used often to be uncomfortably cold. Gradually, their operators have learned better ways of working, for example arranging the computer servers and fans in alternately-facing

rows, so that the fans pump heat into a 'hot aisle' between the rows, in which the backs of the two rows of servers are easily accessible. It's in those pleasantly temperate aisles that Cermak's few maintenance staff, and the occasional engineer who visits, mostly need to work. As you walk around, though, you get constant reminders of what it takes to keep Cermak cool: huge pipes carrying chilled water; the occasional blast of very cold air.

If you are interested in digital finance, as I am, Cermak is endlessly fascinating. The most dramatic episode in the short history of automated trading was the 'flash crash' of 6 May 2010, a sudden huge fall – and then almost as rapid a recovery – in prices, accompanied by widespread disruption of trading. Cermak was where the crash began. It seems to have been triggered by a set of electromagnetic signals – originally generated by an investment-management firm in Kansas City – encoding a big sell order. At Cermak, that order entered a complex electronic ecosystem of trading algorithms, an ecosystem that normally would have been able to absorb it. For reasons that remain unclear, it did not do so on 6 May, so the shock then travelled from Cermak down the fibre-optic cables connecting it to the data centres in New Jersey in which shares are traded, spreading chaos as they arrived.

Human eyes and ears are of limited use in understanding what goes on in a data centre. Even my guide couldn't enter most of Cermak's rooms, which are protected by doors with biometric locks. Once you're inside a room, you get only the most tiny clues as to what's going on. At least in the rooms housing trading firms' servers, the computers are generally in locked cages, and those cages are usually tightly packed: renting space in Cermak is pricey, so you want to make the best use of it. In one room, though, there was a big cage with only three cabinets of servers, surrounded

by expensive, empty floor space. What program could be running on those servers, I asked myself. Alas, I couldn't tell.

Donald MacKenzie